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Endosulfan: a hidden menace

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The use of pesticides in agriculture and human health has been successful in controlling pests and diseases. The application of the organochlorine pesticides such as DDT [1,1,1-trichloro-2,2-bis(parachlorophenyl)ethane] against the malaria mosquito and many other insect pests provided a cheap and effective control for most insect problems. The new pesticide technology also brought in other effective agents such as herbicides (for weeds), avicides (for birds), piscicides (for fish), and molluscicides (for snails) that contributed to the success of farming systems worldwide. But pesticide application has many problems such as the emergence of new pests, persistence in the environment, environmental contamination, and subsequent effect on non-target organisms including humans.

Endosulfan (hexachlorohexaethymethano-2, 4, 3-benzodioxathiepine-3-oxide), a cyclodiene pesticide, also commonly known as Thiodan™ in many countries and Benzoepin in Japan, has been used effectively in the production of fruits, grains, nuts, and vegetables since 1954. New reports say that endosulfan is highly toxic: it is either restricted, not allowed in ricefields, or banned in Southeast Asian countries. Illegal trade and incorrect use (eg. to control golden apple snail in rice paddies) always pose added danger.

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The chemical structure of endosulfan.

C₆H₄Cl₆O₅S

IRAP activity launched
by WG Yap and VT Sulit

After some delay due to various reasons the latest of which was the SARS outbreak, the Integrated Regional Aquaculture Project (IRAP) under the ASEAN-SEAFDEC Special 5-year Program had a soft launching with the first phase of the site visitation and survey conducted from 12 to 23 May 2003.

The initial countries covered were Indonesia, Brunei Darussalam and Malaysia. The SEAFDEC/AQD survey team consisted of these writers and three experts from the Thailand’s Department of Fisheries (DOF) and one from AQD who joined the survey in different places depending on the expertise required. Ms. Sunee Payomjamsri, Food Technologist from the DOF Fisheries Technological Development Division came on board for Jambi, Indonesia; Mr. Sombhong Suwannatos, Senior Aquaculture Advisor of the DOF Fisheries Foreign Affairs Division for Brunei Darussalam; and for Malaysia Mr. Nareupon.
Endosulfan: a hidden menace by rm coloso

is also used against snail pests in rice paddy ecosystems causing alarm among scientists and environmentalists regarding its impact on the surrounding aquatic ecosystem. Perhaps looking again into the use of endosulfan in enhancing agricultural production and its impact on the environment especially when it is used indiscriminately would promote a delicate balance between the demand for higher food production on one extreme and a cleaner and safer environment on the other.

Endosulfan use in agriculture

The endosulfan preparation that is commercially available is a mixture of two chemical forms, α- and β-endosulfan. It is colored cream to brown, may be crystalline or in flakes, may be an amber liquid, and smells like turpentine. The commercially available product Thiodan 3 EC contains aromatic hydrocarbons (less than 37%), 1, 2, 4-trimethylbenzene (less than 19%), surfactant blend (less than 3.4%), xylene (less than 1.8%), cumene (less than 1.2%), ethyl benzene (less than 0.6%), and 1-butanol (less than 0.3%) aside from the active ingredient endosulfan (33.7%) (7).

Endosulfan is used as a pesticide in vegetables such as beans, broccoli, cabbage, cauliflower, eggplant, pepper, sprouts, spinach, squash, and tomato; row crops such as cotton, potato, sweet corn, and tobacco; fruit and nut trees such as apple, apricot, blueberry, nectarine, and peach; grains such as barley, oats, rice, rye, and wheat; and vines such as grape. It is effective against a variety of insects such as aphids, army cutworm, beetles, boll weevils, leafhoppers, leafminers, tree and twig borers, stink bugs, tobacco cutworm, and others (insecticide). It is also effective against mites and ticks (acaricide) and as a wood preservative.

Endosulfan is one of the top 40 pesticides imported into the Asia and Pacific region. Its consumption (4,680 metric tons of active ingredient) in the region in 1995 was third only to DDT and monocrotophos, an organophosphorus insecticide (6,017 and 5,250 metric tons of active ingredient, respectively) (2). It is presently banned in Indonesia, Taiwan, and Singapore; not allowed in rice fields in Bangladesh, Indonesia, Korea, and Thailand; and restricted or severely restricted in the Philippines, Sri Lanka, and Thailand.

Acute toxicity on humans and wildlife

Endosulfan is highly toxic. The WHO classifies endosulfan as a moderately hazardous (category II) pesticide while the US EPA classifies it as highly hazardous (category 1b). In humans, it is highly toxic if ingested orally, inhaled, or absorbed through the skin. The FAO/WHO acceptable daily intake for endosulfan is only 0.000008 g per kg body weight (8 micrograms/kg of body weight per day). Endosulfan poisoning can result from eating contaminated food, drinking contaminated water, breathing contaminated air and touching soil and other surfaces where endosulfan has been sprayed, smoking cigarettes made from contaminated tobacco, and working extensively in an industry using endosulfan. Poisoning results in convulsions, tremors, paralysis, and vomiting, all symptoms of disorder of the central nervous system. As a class, organochlorine pesticides alter both sodium and potassium levels in neurons, thus interfering with normal neurotransmission and triggering muscles to twitch involuntarily. Furthermore, the other ingredients of the endosulfan formulation such as the aromatic hydrocarbons can produce severe pneumonitis and fatal pulmonary edema.

The toxicity of endosulfan varies according to the manner of exposure. In acute experiments, the lethal oral dose (LD₅₀) to rats is 45 milligram/kg. It is less toxic by the dermal route with a dermal LD₅₀ to the rabbit of 256 milligram/kg. The lethal inhalation (LC₅₀) in the rat is 87 micrograms/liter/4 hours. However, endosulfan is highly toxic to fish and other aquatic wildlife. Endosulfan earned its notoriety for spectacular fish kills in the Rhine River in June, 1969. Endosulfan residues in the water reached 5 micrograms/liter in the German section and 0.7 microgram/liter in the Dutch section, values which were in the range of the acute lethal dose in fish of 1-10 micrograms/liter. Compounded by the high water temperature of 19 °C, fish kills occurred in both sections (3). Crustaceans and molluscs are less sensitive to endosulfan (acute LC₅₀ value of 10-1600 microgram/liter). However, some species of shrimp such as the adult grass shrimp Palaeomonetes pugio may be just as sensitive as fish with LC₅₀ value for endosulfan of 0.62 microgram/liter. Furthermore, endosulfan may preferentially affect the male shrimp while endosulfan-exposed females may produce embryos with delayed hatching time (4).
Environmental fate

Endosulfan enters the environment when it is sprayed on crops or when it is accidentally spilled into the soil or water. After spraying, it could reach far distances (spray drift) before it settles on crops, soil, or water. In the soil, it is attached to soil particles especially near dump sites where the pesticide may be inadvertently disposed of. It could then evaporate into the air or stay in the soil for several years before degrading into endosulfan sulfate which is even more persistent than the parent compound. The time required for one-half of endosulfan concentration to decay (half-life or $t_{1/2}$) in sandy loam is 60-800 days. The metabolite endosulfan sulfate is highly persistent (5). In farms regularly sprayed with the pesticide, a significant level of endosulfan sulfate is already present in the soil prior to spraying as residues from previous applications. Lastly, endosulfan in the soil could reach surface water through runoff after a heavy rain (see figure on page 2). However, by staying bound into soil particles, the threat of endosulfan leaching into ground water is low.

Endosulfan does not readily dissolve in water. It forms an emulsion with water. In surface water, it could evaporate into the air or be attached to soil particles that are either suspended in the water column or settled in the sediment. The small amount of dissolved endosulfan breaks down over time. The half-life or $t_{1/2}$ of endosulfan in water and in fruits and vegetables is about 3-7 days. However, despite its fast degradation in water, it can still persist for a long period when bound to soil particles which later become a source of contamination. For instance, contaminated sediment can significantly change the abundance of several groups of macroinvertebrates in freshwater (5). Endosulfan can also build up in aquatic organisms that live in endosulfan-contaminated water, the concentration of endosulfan in the body of the organism becoming higher than its concentration in the surrounding water over time (see figure on this page). Endosulfan is rapidly accumulated and concentrated from surrounding water by freshwater green algae Pseudokirchneriella subcapitatum [Bioconcentration factor (BCF) of 2700 in algae exposed to 100 micrograms/liter for 16 hours] and the freshwater cladoceran Daphnia magna (BCF of 3300 using the same exposure). Direct uptake of endosulfan from water is the major route for its bioconcentration by freshwater plankton (6).

Fish are a good biological indicator for pesticide pollution of aquatic ecosystems. Endosulfan residues have been reported in fish obtained from natural bodies of water near regions where there is widespread use of the pesticide for agricultural purposes. In Kolleru Lake in the Andhra Pradesh region of India, extensive use of pesticides in surrounding farms have resulted in detectable levels of endosulfan in tissues of fish species like Channa striata and Catla catla as high as 77 micrograms/g (7). Endosulfan residues have also been detected in market fish samples in and around Calcutta, India (8). In Mar Chiquita coastal lagoon in Argentina, significant endosulfan and endosulfan sulfate levels were found in tissues and digestive tract of the freshwater fish silverside Odontesthes bonariensis indicating recent and past endosulfan use.
Getting to know you

SEAFDEC’s Deputy Secretary General (and concurrently the Deputy Chief of the Training Department in Thailand) Mr. Junichiro Okamoto visited AQD on April 21 to discuss projects in the ASEAN-SEAFDEC Special 5-Year Program.

Being the first visit of Mr. Okamoto to AQD’s Tigbauan Main Station, AQD Chief Dr. Rolando Platon and Research Head Dr. Clarissa Marte briefed him on the programs, projects, and activities of the department. Dr. Kazuya Nagasawa (new Fish Diseases Expert) joined them in touring the AQD facilities.

About a month earlier, the Chief and Deputy Chief of Marine Fishery Resources Development and Management (the SEAFDEC department in Malaysia) Mr. Ibrahim bin Saleh and Mr. Yoshikazu Nakamura, respectively, also toured AQD. Dr. Marte briefed them on the programs and activities of AQD while FishWorld curator, Dr. Teodora Bagarinoa, toured the two around the station.

AQD is improving strains of seaweed

The Philippine seaweed industry exported about US$130 million worth of seaweeds and seaweed products in 2000. It is currently ranked second top producer and third leading world exporter of seaweeds. The country is also the major producer of Enteromorpha and Kappaphycus, as sources of iota and kappa carrageenan, respectively.

With the increasing demand for hydrocolloids in the world market, it is imperative to improve techniques in both production and quality of seaweed products to remain globally competitive.

The traditional culture of seaweeds Kappaphycus alvarezi, K. striatum, and E. denticulatum since the early ‘70s made use of vegetative branches. However, the repeated propagation of this method for almost 30 years brought problems to the industry, to wit: declining quality of crop and poor quality of carageenan due to inferior seedstock; unstable production; vulnerability to “ice-ice” disease and poor postharvest management. E. denticulatum, whose trade name is spinosum, is an important source of iota carageenan which is used mainly in pharmaceutical and cosmetic applications.

Dr. Anicia Hurtado and other researchers at AQD have addressed this problem of inferior seedstock. They have developed a technique to generate plantlets of E. denticulatum for outplanting purposes. In their study, they demonstrated that tissue culture could generate new strains with superior characteristics suitable for commercial cultivation. By dividing callus (harvested tissue that develops over the cut end of a section) into multiple small calli, it allowed them to increase the number of plants they could produce per section. By culturing regenerants first in the laboratory and then in the field in net cages, they were able to compare the growth rates of individual regenerants for a 4-month culture periods. Presently, the improved strains of E. denticulatum are maintained in concrete tanks at AQD’s Tigbauan Main Station, and also at the Igang Marine Substation in Guimaras for the last two years. The described technique is also applicable to K. alvarezi and K. striatum, both excellent sources of kappa carageenan with wide applications mainly in food preparations.

Priorities on biotechnology

With the completion of the biotechnology research facilities, the Philippine government wasted no time in drawing up priorities for biotech research. Hosted by AQD, a workshop on the topic was organized jointly with the Bureau of Fisheries and Aquatic Resources from March 17 to 18 in Iloilo.

The workshop output included priority research areas to be addressed by AQD, BFAR, or both parties jointly. The research areas fall broadly as: selective breeding, growth enhancement, stock enhancement and husbandry of novel species; disease control; seaweeds and microalgae; and environment-friendly feeds.

BFAR also forwarded research proposals they can implement using their own funds, for 2003 and 2004. Proposals for submission to JICA through DA and NEDA were also discussed.

The workshop was attended by AQD senior researchers and the BFAR core staff for the AQD/BFAR biotech program.

Collaborations with a feed company and a private hatchery

AQD has agreed to collaborate with Hoc Po Feeds Corporation in verifying the effectiveness of the latter’s bioremediation/probiotic product that is considered environment-friendly. The study will be done at AQD’s brackishwater ponds, and for one grow-out period this year. The collaborators will share expenses and harvest profits, and later agree upon any publication that may arise, although Hoc Po must not take mention of its brand name as endorsement by AQD.

AQD is also collaborating with Jamandre Hatcheries Inc. on the development of screening protocols for white spot syndrome virus (WSSV) in the latter’s shrimp hatcheries. The agreement takes effect on April 1 for one year, and may be renewed.

The tie-up will use AQD technology and expertise in developing protocols so that the private hatchery will be able to produce WSSV-free shrimp fry.
Training need survey launched

A training-need survey to accurately determine the requirements of the aquaculture industry was launched at the SEAFDEC website: www.seafdec.org.ph. The survey asks questions about what aquaculture species are important; the length of time a trainee can attend a training course, and a short profile of the respondent (name and address optional), among others.

This newsletter’s readers and their friends and colleagues are invited to participate in this three-month survey.

In related development, six Filipinos completed the Crab seed production training course on May 21; three are learning Management of sustainable farming systems starting May 7; seven are currently enrolled in the Marine fish hatchery course including one from Myanmar; and 19 students of the Philippine Science High School completed their internships in various fields of aquaculture.

Meanwhile, AQD evaluated its online courses with the help of the University of the Philippines Open University in a 2-day workshop, April 23-24, in Iloilo. Some revision of course materials are proposed.

Results of technology extension initiatives

Fishfarmers of Sibunag’s AQD-assisted Mariculture livelihood project in the island-province of Guimaras finally tasted the fruits of their labor on April 28. About 420 kg of grouper worth P102,000 were harvested from seven cages after five months of culture; average body weight was 359 grams.

In Barangay Parara Norte, near AQD’s main station in Iloilo, fisherfolk harvested 15 tons of seaweeds from March 24 to April 6. Of the harvest, 8.6 tons were dried and sold, < 1 ton sold as fresh, and 6.7 tons replanted for the second cropping. This bounty from the AQD-sponsored project on Rural development benefits an association of more than 50 members.

In addition to direct technology assistance, AQD also sends lecturers all over the country to talk on viable technologies. On April 9, AQD staff were in Sasmuan, Pampanga as requested by the BFAR Regional Director to lecture on Environment-friendly schemes for modified-extensive and semi-intensive shrimp farming. Forty-five extensive shrimp operators and technicians attended the lecture.

From April 10 to 11, a seminar was conducted in Iba, Zambales, and dealt with breeding and grow-out culture techniques of economically important fishes and crustaceans, as well as processing, and preparation of value-added products. Around 70 participants attended the seminar.

March 23 to 25, and AQD was in Tangub City in Mindanao to conduct a seminar-workshop on Environment-friendly shrimp culture. More than 30 pond operator-members of the Aquaculture Multipurpose Cooperative attended. Another 10 beneficiaries of DOST’s Consultancy for Agricultural Productivity Enhancement (CAPE) in Misamis Occidental were also in attendance. The coop and DOST requested the seminar-workshop.

March 26 and 27 were for the BFAR extension officers under the Giaintuang Masaganang Ani (GMA)–Fisheries Program. It was held at the Freshwater Fisheries Research Station in Bambang, Los Baños, Laguna. The seminar was on Environment-friendly intensive shrimp culture.

New disease expert

On March 14, exactly a month after disease expert Dr. Yasuo Inui left for Japan to retire, his successor, Dr. Kazuya Nagasawa, 50, begins his two-year tour-of-duty at AQD.

Dr. Nagasawa is a Director-Fish Parasitologist at the National Research Institute of Aquaculture (NRIA), Fisheries Research Agency. His academic background includes a PhD degree in Fisheries (parasitology, 1981) and a Masters degree (parasitology, 1978) from the University of Tokyo. His employment record includes stints at the Hokkaido Prefectural Government as researcher for 10 years, the national government as Chief Scientist for more than 3 years, and at the NRIA as the Director of the Nikko Branch.

Dr. Nagasawa co-authored several books related to fish parasites and diseases in both Japanese and English publications. He also served as editor-in-chief of the International Ichthyoparasitological Newsletter of the International Group for Fish Parasitology. Likewise, he served in the editorial board of the academic journals Fish Pathology and the Journal of Marine Biological Association of the United Kingdom which is published by Oxford University Press.

He is a member of several international academic societies including: The Japanese Society of Scientific Fisheries, Japanese Society of Fish Pathology, American Society of Fish Parasitologists, International Crustacean Society, and the International Group for Fish Parasitology.

His expertise on fish parasites and diseases has led to several invitations overseas as an invited lecturer including among others: The Ocean Research Institute of Kiel University, Germany; Natural History Museum, London; Institute of Fisheries and Oceanography, Kamchatka, Russia, and the Fisheries Research Institute, University of Washington, Seattle, USA.

As expert of the Regional Fish Disease Projects which is funded by the Trust Fund of the Japanese Government, Dr. Nagasawa will continue to promote projects and networking in the region, develop disease control techniques, and strengthen the R & D capability for fish disease at AQD.

Dr. Nagasawa is married and has two sons.
**Dr. Yasuo Inui thanks AQD as his tour-of-duty ends**

**Dear friends and colleagues:**

My assignment with JICA will end on March 14. Junko and I will return to Japan on the same day with our old dog Poppy.

My principal task in AQD was to plan, manage, and promote the Regional Fish Disease Projects funded by the Trust Fund of the Japanese Government and by promoting the project, develop the disease control technique and network in the region and improve R&D capability for fish disease in AQD. The Regional Fish Disease Project has been so far successful. I am also confident that the (level of) science of fish health in AQD has been upgraded. The success is totally due to the positive activities of Fish Health staff and researchers of other organizations involved in the project and kind support and collaboration of other people to our activities: all the members of AQD, Japanese Government, SEAFDEC Secretariat, colleagues from my former Japanese Institutes and scientists from the Academe had given big support to our activities.

I also enjoyed various scientific activities in AQD: it was my pleasure to be involved in scientific discussions, attending scientific meetings such as SEAFDEC seminars, Commodity and Program Committee meetings. I am also very happy that I could contribute to the establishment of the Biotech facilities. The facilities and equipment are the highest grade in this region and I hope this will be efficiently utilized to contribute to fisheries science. I am very lucky that I can see the completion of the facilities in time for my departure.

I will be succeeded by Dr. Kazuya Nagasawa. He is a younger and very able scientist and deeply (dedicated) to the science of fish disease. I feel very relieved and happy that Dr. Nagasawa succeeds my position and extend our activities in Fish Disease Project. I ask all my friends to be good and supportive to him as they were to me.

Junko and I enjoyed very much life in the Philippines. Frankly speaking, we were not familiar with the Philippines before we came here. Now we learned a lot about history, culture and the Filipino thinking by actually experiencing life in the country. We also enjoyed visiting various attractive places in the Philippines. As such, the Philippines has now become another home country to us.

Life in AQD was comfortable and enjoyable for me. All staff, not only the scientists, were friendly and kind. Many people tried to make my stay in AQD and Iloilo enjoyable.

Sports was another factor that gave pleasure to my life in Iloilo. Through the SEAFDEC tennis club, I made many good friends and of course enjoyed after office-hour tennis. The Villa tennis club near our house was an important part of my weekend life. Tennis there was exciting and all people were kind and good.

I have not lost the interest and passion for science. However, after I go back to Japan I will not have a fulltime job. Rather, I plan to take more time to enjoy life: enjoying nature, experiencing deeper the Japanese and other cultures, reading, sports, etc. By doing these, I also like to consider my future contribution to the society.

Madamo gid nga salamat,
Yasuo Inui

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**British PhD student on internship**

James Stevenson, 25, of Surrey, London, England is on an Internship Training at AQD’s Research Division. His two-month (April and May) project assignment is on the sustainability of brackishwater aquaculture.

James has a BS Zoology degree from the University of Bristol (1999), MS in Ecological Economics at the University of Edinburgh (2001) and is currently earning his doctoral degree at the University of Reading in UK. He is also currently employed at the Department of Agricultural and Food Economics of the same university.

James presented a seminar on April 8 in Iloilo titled Sustainability as compromise: a policy framework for comparing the performance of brackishwater aquaculture systems. He reported on the planned activities of a collaborative project between British and Philippine partners, funded by the UK Department for International Development, (OFID). The project’s objectives are two-fold: to establish a typology of brackishwater pond production systems in the Philippines that can be reliably used to guide policy. So far, no typology using quantitative methods has been carried out in the Philippines and this is a key oversight in understanding the subsector.

The second objective is to develop an understanding of the trade-off at the farming system level, between economic, social and environmental criteria. The simple hypothesis that such trade-off exists mandates that these effects be studied in their own dimensions, in order that we can judge the different economic performance of fishponds in the context of environmental degradation and social acceptability and equity impacts. This proposal serves as a means of operationalising the sustainability concept in practical policy guidance.

Abstract. The amount of microcystin in Microcystis aeruginosa bloom was investigated during the rainy season of 1999 in Laguna de Bay, the Philippines. Bloom samples taken from the West Bay and East Cove stations of the lake were studied in relation to the characteristics of environmental conditions. Four types of microcystins, microcystin-LR (MC-LR), microcystin-RR (MC-RR), (Z)-Adda-microcystin-RR, and 3-desmethylmicrocystin-LR were identified from the natural bloom samples among which MC-LR was the most dominant type of microcystin. Production of microcystin (88.6 µg/100 mg dried cells) was highest during the first sampling week that coincided with high water transparency and high conductivity. The occurrence of a strong typhoon during the second sampling week had changed the environment drastically, which was characterized by low water transparency, high turbidity, low water temperature, and with trace amounts of MC-LR detected at the East Cove station. Thus, toxin production over time as well as the relationship between Microcystis production and toxin concentration could not be fully evaluated.


Abstract. Growth studies were conducted to determine the suitability of animal and plant protein sources in the diet of abalone, Haliotis asinina. Juvenile abalone with mean initial weight and shell length of 0.69±0.04 g and 11.4±0.35 mm, respectively, were fed practical diets for 84 days at a temperature range of 28-31°C. The practical diets contained 27% crude protein from various sources such as fish meal (FM), shrimp meal (SM), defatted soybean meal (DSM), and Spirulina sp. (SP). A formulated diet (diet 1) served as the control. The diets were fed to abalone at 2.5% body weight once daily at 1600 h. Weight gain (WG), increase in shell length (SL), specific growth rate (SGR), protein efficiency ratio (PER) and feed conversion ratio (FCR) were evaluated. Highest weight gain (WG: 454%) was attained with abalone fed diet 2 with protein sources coming from a combination of FM, SM, and DSM. This value was, however, not significantly different (P < 0.05) from those fed diets 4 and 1 (control diet) with protein sources coming from FM, SM, SP and FM, DSM, SM, respectively. Abalone fed diet 3, which used both plant protein sources, DSM and SP, showed significantly lower WG (327%). Survival was generally high ranging from 85% to 100% for all treatments. The SGR showed the same trend as the percent weight gain. The FCR and PER obtained, however, were not significantly different for all treatments. The amino acid profile of diets 1, 2, and 4 simulated that of the abalone protein, which could have been a contributing factor to the higher growth rate of abalone fed these diets. Diet 3, which contained only plant protein sources, showed relatively lower methio-nine values compared with the abalone muscle tissue. Although abalone are considered herbivorous animals, results of this study indicate that a combination of dietary plant and animal protein sources was necessary to attain the best growth rate.


Abstract. A feeding experiment was conducted to determine apparent digestibility coefficients for dry matter (ADMD), crude protein (ACPd), crude fat (ACFbD), crude fiber (ACFd), nitrogen-free extract or NFE (ANFED), and crude ash (AAD) of selected feed ingredients for mud crab, Scylla serrata. The nine feed ingredients were Peruvian fish meal, squid meal, Acetes sp., meat and bone meal, copra meal, wheat flour, rice bran, corn meal, and defatted soybean meal. A reference diet (RF) and test diets (consisted of 70% RF diet and 30% of the feedstuff) were used with Cr2O3 as external indicator. The ADMD of the RF and test diets were high except for meat and bone meal. Crude protein, crude fiber, and ash of feedstuffs were digestible in mud crab. Nutrients in squid meal, corn meal, and defatted soybean meal were digested well (ACFbD > 95%; ANFED>92%; AAD>71%) compared with nutrients in the meat and bone meal. The AAD of copra meal, wheat flour, rice bran, and meat and bone meal were similar. The ACFD in carbohydrate-rich plant feedstuffs were significantly higher than that in protein-rich animal feedstuffs. For this species, the relative amounts of dietary protein and NFE in feedstuffs had an effect on the ACFD but not on ADMD.


Abstract. Optimum packing conditions for the transport of hatchery-reared and wild grouper larvae were investigated under simulated condition or actual air transport. Simulation of transport motion was done through the use of an electric orbit shaker to identify the best packing conditions for the transport of grouper larvae at various ages. Simulated transport was conducted in hatchery-reared grouper larvae at day 35 (mean TL= 14.73 mm), 45 (mean TL= 15.23 mm) and 60 (mean TL= 28.16 mm) at packing densities of 50, 100 and 200 larvae l-1 and at high (28°C) or low (23°C) temperatures. Packing density of 50 larvae l-1 was best for 45- and 60-day-old larvae 8 h transport at low temperature. However, packing density could be increased to a maximum of 100 larvae l-1 8 h transport at 23°C with mortality rates ranging from 2.3% to 5.3%. The increase in total NH3 level was dependent on temperature, packing density and size of larvae. High packing density (100-200 larvae 1 l-1) and temperature (28°C) resulted in increased NH3 level and mortality rates during transport. In addition, regardless of the temperature, NH3
levels were consistently higher for 60-day-old larvae. Day-60 grouper larvae displayed strong resistance to handling/mechanical stress compared to 35-day-old larvae probably because most are already fully metamorphosed at this stage. Based on these results, a packing density of 50 larvae 1⁻¹, a temperature of 23°C and larval age of 60 days were considered as the best transport conditions for hatchery-reared grouper larvae. When these transport conditions were used in experiment 2, for 26-day-old hormone-metamorphosed, 60-day-old naturally metamorphosed or 60-day-old pre-metamorphosing hatchery-reared grouper larvae, a 100% survival rate was attained in all treatments. Seven days of hormone (T3) treatment did not accelerate metamorphosis of wild-caught transparent grouper larvae (tines) significantly. Survival rates of hormone-treated transparent times (T-times), untreated black times (B-times) and untreated transparent times (T-times) were also similar after 8-9 h air transport (experiment 3). The results of the current study suggest that T3 treatment did not affect the performance of hatchery-reared and wild-caught transparent times/larvae during transport. In addition, mass mortalities of these transported times during the nursery phase were associated with nutritional aspect and the sudden confinement of these undomesticated wild-caught grouper to small space rather than transport or hormone treatment effects.


Abstract. In line with current conservation efforts, some success in the captive breeding of the seahorse Hippocampus kuda (Teleostei: Syngnathidae) has been achieved. To evaluate the salinity tolerance of these hatchery-bred juveniles, 9-week-old H. kuda were transferred without prior acclimatization from ambient full strength seawater (32-33 ppt) to salinities ranging from freshwater to 85 ppt. Survival, growth, and total body water content were determined after 4 and 18 days of exposure. Juvenile H. kuda were able to survive in diluted seawater (15 ppt) for at least 18 days without any compromise in growth (both wet and dry body weight), survival, and total body water. Fish abruptly transferred to freshwater succumbed within 4-24 h, while survival of 5 ppt-reared fish decreased to ca. 65% in 18 days. Although 10 ppt-reared seahorses had growth and survival comparable with the control (30 ppt seawater), indicating a stimulation of spermatozoa production, not merely milt dilution due to hydration. In a second experiment, sperm count and spermatocrit were significantly lower than those of saline-injected fish at 17 and 48 h after a single injection of a high dose of LH-RHa (80 μg/kg BW). A methyltestosterone injection combined with the LH-RHa injection also resulted in a significantly lower sperm count, but the spermatocrit remained comparable to the control group, suggesting a suppression of the LH-RHa-induced milt hydration response. Results demonstrate that LH-RHa stimulates milt hydration and spermatozoa production in milting sea bass and that a simultaneous methyltestosterone injection partially suppresses this response.


Abstract. Optimization of culture conditions with regard to the combined effects of salinity and temperature on biomass and fatty acid production of four thraustochytrid isolates were undertaken. Two strains of Schizochytrium mangrovei (IAo-1 and IXm-6), and one isolate each of Schizochytrium sp. (BSn-1) and Thraustochytrium sp. (IRa-8), isolated from fallen mangrove leaves, were used in this study. Results of the physiological study show that the best growth condition for Schizochytrium isolates was at a salinity range of 15-30 ppt at 20-25°C, while that for Thraustochytrium sp. was at 22.5-30 ppt at 25°C. Highest biomass production was 350 mg 50 mL⁻¹ for Schizochytrium spp., and 133 mg 50 mL⁻¹ for Thraustochytrium sp. Total lipid content (% freeze-dried biomass) ranged from 16.0-33.2% for S. mangrovei, 13.039.1% for Schizochytrium sp., and 11.4-37.5% for Thraustochytrium sp. Highest lipid production was observed at 15-22.5 ppt salinity (25°C) for S. mangrovei, and at 15 ppt (25°C) for Schizochytrium sp. and Thraustochytrium sp. Palmitic acid (16:0) and docosahexaenoic acid (DHA; 22:6n3) were the major components of the total fatty acid (TFA) content, comprising about 39-42% and 24-35%, respectively.


Abstract. The effects of diet (fish bycatch or a mixed diet of 75% brown mussel flesh and 25% cooked cracked corn) and harvesting regi-
men (bimonthly selective harvesting, or single terminal harvesting) on
growth, survival and production of mud crab Scylla olivacea (Herbst) in
brackish water ponds were determined in a replicated factorial experi-
ment. The crabs were stocked at 0.6 individuals per m² for 118 days.
There was no significant interaction (P >0.05) between the diet and har-
vesting regimen treatments. Regardless of diet, the survival rate and net
production of mud crabs were significantly higher (P <0.05) when crabs
were subjected to bimonthly selective harvesting than at single terminal
harvest. Comparative cost-return analysis showed that bimonthly selec-
tive harvesting and mixed diet treatments attained higher net return and
return on investment, and lower cost of production than the other treat­
ments. Partial budgeting analysis showed that bigger profits can be earned
by using a bimonthly selective harvesting and a mixed diet of 75% fresh
or fresh-frozen brown mussel flesh and 25% cooked cracked corn.

Sumagaysay-Chavoso NS, San Diego-McGlone ML. 2003. Wa-
ter quality and holding capacity of intensive and semi-intensive
milkfish (Chanos chanos) ponds. Aquaculture 219 (1-4): 413-429

Abstract. This study determined the holding capacity of semi-in-
tensive and intensive milkfish ponds and water quality in relation to fish
biomass and feed input. Six units of 1000 m² brackishwater ponds were
used, three ponds for intensive system (20,000 fish ha⁻¹) and three for
semi-intensive system (8000 fish ha⁻¹). Average production was signifi-
cantly higher in intensive pond (3652 kg ha⁻¹) than in semi-intensive
pond (1352 kg ha⁻¹) after a desired marketable size of fish was reached.
Highest concentrations in effluents (mg l⁻¹) of rearing water measured
every 2 weeks were 0.369 and 0.289 for chlorophyll a (chl a), 0.485 and
0.512 for PO₄-P, 0.279 and 0.811 for TAN, 0.094 and 0.082 for NO₃-N,
and 14.040 and 8.649 for total suspended solids (TSS), 15.0 and 21.7 for biological oxygen demand (BOD), in intensive
and semi-intensive ponds, respectively. Lowest morning dissolved oxy-
gen (DO) in intensive pond was 2.2 mg l⁻¹, and did not decrease further
because of aeration. In un aerated, semi-intensive pond, morning DO
ranged from 1.3 to 5.0 mg l⁻¹ but occasionally went below 1.0 mg l⁻¹
resulting to fish mortalities at biomass of 835, 1206, and 1489 kg ha⁻¹.
Levels of NO₃-N and dissolved inorganic N are linear functions of fish
biomass or feed input in all systems (P <0.05). The buildup of nutrients
is more pronounced at biomass of 1610 kg ha⁻¹ and above while nutrient
transformation (conversion of PO₄-P or TAN to phytoplankton or vice
versa) is apparent at biomass below 1419 kg ha⁻¹. The holding capacity
of unaerated, semi-intensive pond is below 1348 kg ha⁻¹ or 54 kg feed
ha⁻¹ day⁻¹ based on DO concentration of less than 1.0 mg l⁻¹. However,
the holding capacity can be lower than 835 kg ha⁻¹ or 33 kg feed ha⁻¹
day⁻¹ during very calm weather or during rainy days when water column
is stratified. Based on the results of regression analysis, the holding ca-
pacity of intensive pond should be set below 5107 kg ha⁻¹ or 110 kg feed
ha⁻¹ day⁻¹ so as not to exceed the acceptable levels for water quality
variables in effluent waters.

Tendencia EA, dela Pena M. 2003. Investigation of some com-
ponents of the greenwater system which makes it effective in the
initial control of luminous bacteria. Aquaculture 218 (1-4): 115-
119

Abstract. Two components of the greenwater system, the tilapia
water and Chlorella, were investigated separately for their effect on the
population of luminous bacteria. For the investigation of tilapia water,
Tilapia hornorum was stocked at different biomasses 0, 1 and 3 kg/10
m². Vibrio harveyi was introduced to the tanks at a final concentration
of 10³ cfu/ml. Luminous bacteria could not be detected in tanks stocked at
3 kg/10 m² from day 4 to day 6, and on day 6 in tanks stocked at 1 kg/10
m². The bacteria could still be recovered in tanks without tilapia on day
6. Investigation of the effect of Chlorella alone on V. harveyi was under-
taken using sterile flasks containing 500-ml autoclaved seawater pro-
vided with aeration. In treated flasks Chlorella was added, whereas no
Chlorella was added to control flasks. No luminous bacteria were recov-
ered on day 2 and day 3 in flasks with Chlorella, while those without the
microalgae still harboured luminous bacteria at day 3.

NOTE: ABSTRACTS FROM JOURNALS COVERED BY CURRENT
CONTENTS ARE DOWNLOADED FROM THE CD-ROM VERSIONS
(Agriculture, Biology & Environmental Sciences, 30 July 2001 – 22 July 2002
or from Life Sciences, 29 April 2002 – 21 April 2003). 2002. INSTITUTE FOR
SCIENTIFIC INFORMATION, PENNSYLVANIA, USA ###

Congratulations to our colleagues!
As the saying goes, better late than never, and so 13 of our
AQD colleagues are to be commended for their persistence
and perseverance in earning a college degree despite
advancing middle age. All 13 graduated on March 21 with a
Bachelor in Fishery Technology degree from the Il hoi State
College of Fisheries (ISCOF), Barotac Nuevo, Iloilo.
The graduates were: Rico Andrada,
Menelio Argues, Jerry Babiera, Edwin Balbon,
Romeo Buendia, Joy Entusiasmo, Gerald Gonzaga,
Sotero Magallanes, Angelo Miranda,
Nelson Tibubos, Pactia Bantillon, Maaila Sobejano,
and Rosalinda Tumanan. The graduates were the
“survivors” of hatch 1999’s 40 enrollees. Classes
by ISCOF’s School of Distance Education were held at
AQD’s Conference Room every Sunday.
IRAP activity launch by yap and sulit

Sukumasawin, Fisheries Biologist from the DOF Inland Fisheries Research and Development Bureau, and Dr. Leobert dela Peña, SEAFDEC/AQD’s very own scientist with the Fish Health Section.

IRAP is an outcome of the Millenium Conference held in Bangkok in 2001. Several projects have been identified for implementation by the four Departments of SEAFDEC. Two of these are aquaculture projects, which will be undertaken in all the ASEAN countries with the exception of Singapore. The projects are based on proposals submitted by the ASEAN National Coordinators during the IRAP Seminar Workshop held in September 2002. Thus the choice of species and the site where the projects would be undertaken were all selected by the respective countries. Each country shall have two projects, one under Supply of Good Quality Seeds and the other under Aquaculture for Rural Development.

First stop: Indonesia

Our first stop was Jakarta and we flew in via Bandar Seri Begawan on Royal Brunei Airlines in order to avoid going through Singapore. Our plane was a bit late but we were met at the Javanese-kraton inspired Soekarno-Hatta Airport in Cengkareng by Mr. Anto Sunaryanto, ASEAN National Coordinator for Indonesia. There was no SARS check in Cengkareng, we only had to fill in a health form.

In Indonesia the survey team visited the Freshwater Breeding and Aquaculture Research Station in Sukamandi on the first day. Of particular concern was the readiness of the facilities and the staff to evaluate different strains and produce good quality seeds of the giant freshwater prawn, Macrobrachium rosenbergii.

The team flew to Jambi province in Southwestern Sumatra to look at the culture of Pangasius in earthen ponds in Tangkit, Muaro Jambi District and in wooden cages set along Batanghari River. The team also visited one fish farmer who is also engaged in the smoking of Pangasius. The problem in Pangasius culture was reported to be one of marketing – hence the expert invited, Ms. Sunee, was on fish processing. In Tangkit the team learned that the fish is now displacing pineapple, the area’s main crop because of its greater profitability.

While in Jambi the team took the chance to visit Balai Budidaya Air Tawar (Freshwater Aquaculture Development Center) Jambi and were able to meet Mr. Yoshitetsu Nukiyama, who was one of the first batch of seven Japanese experts sent by JICA to SEAFDEC/AQD when AQD first opened. Nukiyama-san’s two children (a daughter and a son) were both born in Iloilo. His daughter is now working in the Japanese Embassy in Brunei Darussalam while his son is making a movie somewhere in New Zealand. Nukiyama-san has already spent 15 years in Indonesia first in South Sulawesi and later in Gondol, Bali. Nukiyama-san is now the JICA Team Leader in Jambi where aside from himself there are four long-term and two short-term experts.
Getting stuck on the way to Puncak
From Jambi the team returned to Jakarta and from the airport in Cengkareng we were driven to Sukabumi in West Java to visit the Freshwater Aquaculture Development Center (FADC). The trip should normally not take more than 3 hours but it was May 15, a Thursday and the start of a 4-day weekend on the occasion of Waisak, the Buddhist New Year (Visakha Bucha Day) which is also a national holiday in Indonesia. And it seems like everybody and their uncles in Jakarta were on the road to Puncak (pronounced Poon-chak), the famous hill top resort that is noted for its tea plantation. The major artery to Puncak also leads to Sukabumi so just like their counterparts in the Philippines the Indonesian motorists filled the whole street even the opposing lanes. It was a monumental traffic jam which our Sukabumi based driver was able to skirt by taking little known roads.

Sukabumi has an elevation of 700 m and therefore has a cool climate just like Puncak so it also had its share of holiday travelers though not to the same extent as Puncak. It is the center for freshwater fish breeding including ornamentals. This is probably the reason why the FADC was located there using an old agriculture station established by the Dutch. The Center is very well equipped with earthen and concrete ponds, culture tanks and laboratory facilities. A PCR is scheduled to be delivered this year. With a staff complement of more than 200 it can rival SEAFDEC/AQD’s Tigbauan Main Station for sheer size. Many of the technical staff have advanced degrees and many has undertaken specialized training abroad including at AQD.

Sukabumi is also noted to be the source of many of Jakarta’s movie stars – but we learned this much later when we were already in Malaysia! Too bad! But then we couldn’t have lingered since Indonesia was only the first stop. Without any chance to even drop by Sarinah to shop for the usual pasalubong, Jakarta’s famous department store, which specializes in Indonesian products, the AQD team flew to Bandar Seri Begawan, the capital of Brunei Darussalam.

As in Indonesia all we had to do was fill in a health form, which asks whether we have been to SARS-infected countries during the last two weeks.

Brunei: land of the lush and the plush
We were met at the airport by, who else — but former “AQD’ers” Beato “Jun” Pudadera and Ramon “Monchit” Agbayani. Monchit has been in Brunei for 17 years and Jun even longer. Both are considered stalwarts in Brunei’s aquaculture sector. Jun is Fisheries Officer with the Fisheries Department and Monchit the General Manager Semaun Prim Sdn Bhd, the fishery agency’s investment arm. But they work closely together. They are now into the third generation Penaeus stylirostris, which were introduced as SPF stock by another ex-AQD staff, Leonardo “Bong” Tiro and so far they were able to maintain the stock as SPF. Due to the good performance of the introduced species which can attain 30 g in 4 months, the government is intent on promoting it further and Monchit is now busy supervising the construction of a state-of-the-art, biosecure maturation and breeding facilities which of course can also be used to produce SPF P. monodon. (At the rate we are moving, before we know it the Philippines may find itself sending people to Brunei to observe and train on shrimp domestication.)

IRAP of course is not concerned with the penaeids. In fact Brunei has selected
Macrobachium as the species to work on for both the seed quality and rural development projects. But a look at their facilities and dialogue with the DOF staff made it apparent that they are capable of producing good quality seeds not only of Macrobachium but with proper training, of any species. With a population of only 360,000 at last count it would seem that Brunei do not have a rural area for development. (To provide a perspective the SM Megamall along EDSA in Metro Manila has a daily traffic of between 300,000 to 400,000 people.)

Brunei must be an environmentalist’s idea of heaven. Three quarters of the country has forest cover and the government has a no-cut policy preferring to import all its timber. When the team was taken to Temburong district by speedboat across Brunei Bay, the lush virgin mangrove lining both sides of the tidal river where the boat docked, was a sight to behold. We could have gone to Temburong by land but that would have meant cutting across a tongue of the Malaysian state of Sarawak and that would have meant some prior arrangement for a transit visa (for Filipinos). Temburong is not contiguous with the other three districts of Brunei.

The DOF staff brought us to two fish farmers who are potential cooperators for the Aquaculture for Rural Development, which in Brunei involves Macrobachium culture. The first farmer, Mr. Zacariah, actually works for the local government office of Temburong full time and aquaculture is merely a relaxing sideline. He now raises tilapia and common carp.

The other, Mr. Mohammad Saidi Bin Abdullah, is a full time farmer in Labi village, Belait District. In addition to his fishpond Awang Saidi has a tangerine grove, which produces very sweet dalandan. AQD staff will probably remember him as a former trainee in freshwater aquaculture. And he has fond memories of Tapao Point so much so that he also would like his son to, one day, go to the Philippines to learn fish culture.

He has already tried raising Macrobachium using juveniles supplied by the Department of Fisheries. His survival was alright but the main problem was uneven sizes with only a few males attaining large sizes while most were undersized. But next time around with his interest and a little guidance from IRAP experts he should have a more evenly-sized prawn harvest.

A delightful steamboat dinner hosted by Mr. Haldidi, Brunei’s National Coordinator capped our Brunei sojourn. And just as we thought we were headed back to the hotel Jun Pudadera took us to a night tour of the Empire Hotel premises. This opulent hotel, 7 stars they say in Brunei, was rushed into completion for the APEC meeting in year 2000. One walks in at the street level entrance to find oneself gazing down at the vast lobby which must be about five floors below. The view is dizzying to say the least.

Malaysia: truly Asia

The next morning saw us on the Royal Brunei Airlines flight to Kuala Lumpur. The magnificent Kuala Lumpur International Airport arrival area was SARS ready. Not only did we have to fill in a health form we also have to stand briefly inside a high tech metal-detector like structure which turns out to be equipped with a thermal scanner and an imager. It was manned by three people who, with their white uniforms and face masks and gloves looked like nurses. The computer monitor shows your face and your body temperature in large digits. Presumably if one’s temperature is 38 degrees or higher, one can be held for further check and a possible quarantine. Makes you wonder if you can still get DSA, if God forbid, one gets quarantined!
After a rather lengthy wait we were finally on board the Malaysian Airlines flight to Kuala Terengganu. Kuala in Malay means mouth of the river. The Terengganu airport terminal just like Iloilo’s pride in Mandurriao is also not equipped with a baggage conveyor so we have to jostle for our baggage in the cramped baggage claim area. Because of the large number of passengers it took us some time to claim our baggage. Mr. Ibrahim Saleh, SEAFDEC/MFRDMD Chief who was on his way to Kuala Lumpur, had to check what was holding us and told us that his staff, Mr. Jamaluddin (he preferred to be called Din) and driver Nordin were outside waiting for us and wondering whether we have arrived. Terengganu we were told is opposition country – reason why a new terminal, long overdue, cannot be built.

Malaysia had identified the Marine Finfish Production and Research Centre in Tanjong Demong in Terengganu as the site for implementing the Good Quality Seed Project and grouper is the species of choice. On the way to Tanjong Demong using an MFRDMD van with Din as our guide, we first had to pick up Leobert at the airport since he had to sleep in KL because the flight from Manila does not connect with the last flight from KL to Terengganu. Tanjong Demong is about 90 minutes north of Kuala Terengganu, the state capital.

At Tanjong Demong the main species being propagated is siakap or sea bass, Lates calcarifer. Here they produce 2 cm-long fingerlings, which are distributed to several earthen nursery pond operators within the area where these are reared to 10-12 cm fingerlings to be sold to cage operators. The center also has mangrove snapper and two species of grouper, the humpback (Cromileptis altivelis) and the giant grouper although they have no intention of breeding the former due to its slow growth and low market demand even if it is more expensive.

They prefer to develop the technique to propagate the giant grouper, Epinephelus lanceolatus because of its rapid growth. In this they are seeking the assistance of Indonesia’s Dr. Ketut Sugama whose services shall also be engaged by AQD under IRAP. Dr. dela Peña’s role is to introduce the protocol for producing specific pathogen free grouper fingerlings developed at AQD under the Regional Fish Disease Program.

The team made a quick visit of SEAFDEC/MFRDMD facilities in Chendering, Kuala Terengganu. A briefing of their activities was made by Dr. Mansor Mat Isa, in the absence of its Chief Ibrahim Saleh who was in KL for an important meeting.
The site selected by Malaysia for implementing *Aquaculture for Rural Development* is the KADA Irrigation Canal in Pasir Putih which is in the neighboring state of Kelantan. The area is about 3 hours north of Kuala Terengganu and about an hour’s drive away from the Malaysian-Thai border. In Pasir Putih we were met by Mr. Salehan bin Lamin, Malaysia’s Technical Coordinator for the project who flew in from KL just to be with us. On hand also was the head of the Kelantan State Fisheries Department, Haji Hussain Rahman and Pasir Puteh District Fisheries Office Head, Mr. Kamaruddin Awang.

We drove to the irrigation canal which was developed and is being operated by the Kelantan Agriculture Development Authority (KADA). It is 625 km long with at least 50 km identified as not affected by runoffs from farms and is therefore suitable for aquaculture. The cages consist of 40 units and were put up by the Sultan of Kelantan. Officially the IRAP project will be implemented through the *Royal Fish Cage Culture Project*. The cages are being operated by five farmers and are intended to be a demonstration of the potential of fish cage culture to increase household income in the rural area. Being raised in the cages are tilapia, *Pangasius*, catfish (*C. gariepinus* hybrid) and climbing perch (*Anabas testudineus*).

At the site the Royal Project had prepared a simple feast for us consisting of steamed glutinous rice and fermented fish, young coconut and tangerines. The fermented fish or ikan pekasam that was served was made from undersized *Pangasius* using a traditional method. These are packed in nice plastic containers and sold in stores and even at the airport.

We also visited a fishpen operator who has been in the business since the late 1990s. His fishpen (as are all other fishpens in the canal) was built by simply stretching a net across the whole 60 m width of the irrigation canal about 300 meters apart.

These are stocked with ikan baun (*Mystus* sp), *Pangasius*, tilapia, Java barb (*Barbodes gonionotus*), hybrid catfish and even *Colossoma* which is an exotic species from South America that is closely related to the piranha. He has an average daily sales of about 50 ringgit (US$1.00 = MYR 3.78) and nets him about 30 ringgit. At 3.78 ringgit to the US dollar this is equivalent at an average daily earning of close to US$8.00. And he is already happy about it. And who wouldn’t be? Hopefully IRAP will also lead to more happy fish farmers in the rural areas of Southeast Asia.

**NOTE**

TECHNICAL ACCOUNT OF THE COUNTRIES VISITED WILL BE INCLUDED IN SUBSEQUENT ISSUE

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**laos PDR**

**An aquaculture profile**

The membership of Lao PDR to SEAFDEC solidifies the Southeast Asian voice on sustainable fisheries as it brings together ten nations under one organization. Lao PDR is particularly interested in aquaculture training, verification, and policy formulation.

What does its aquaculture industry look like? For one, the Lao PDR government recognizes the significant role of aquaculture in enhancing food security and increasing income among rural communities. However, aquaculture development is constrained by insufficient seed supply, low capability in technical improvement and development, inadequate extension activities, and lack of manpower with adequate aquaculture skill at national, provincial and district levels.

Second, the indigenous fish species extensively bred and cultured in Lao PDR is Java barb (*Barbonymus gonionotus*) while a few farmers raise snakehead (*Channa* sp.) and giant gourami (*Osphronemus goramy*). Fingerlings of *B. gonionotus* were introduced in a Nongteng fish farm in 1978 from Nongkhai Fisheries Station, and were successfully bred for the first time in the country in 1980. Subsequently, other species were introduced, including isok barb (*Probarbus jullieni*), small scale mud carp (*Cirrhinus microlepis*), spotted *Pangasius* (*P. larnaudii*), giant gourami (*Osphronemus goramy*), and sutchi catfish (*P. hypophthalmus*).

Third, Lao PDR has 202,000 km² of the total Mekong catchments. As of 2000,
over 92% of the households who own ponds are cultivating fish, and 8% of the households are cultivating fish with rice. Other culture systems employed are integrated farming with livestock and fish seed production, cage culture in streams and reservoirs, hatchery and nursery farming systems, and fish stock enhancement in small water bodies.

Most fishponds are shallow and hand constructed. These are stocked in June as the ponds are rainfed, and harvested between November and February. Fertilization of fishpond is relatively common, although quantities are often inadequate.

Aquaculture as a means for rural development in Lao PDR has had a relatively recent history, beginning in 1950s with United States Agency for International Development (USAID) and Japanese foreign aid developing government hatcheries across the country. The country has no hatchery before 1960. Few farmers have traditionally caught wild fry of indigenous fish species for introduction into paddy fields or water impoundment as well as in their ponds. Since 1960, hatcheries were established in Vientiane, Luanprabang, Xayaboury, Savannakhet, and Pakse provinces with USAID assistance. Subsequently, in early 1970s hatcheries were also built in Houphanh, Xiengkhuang, and Oudomxay provinces with assistance from Vietnam and China. In that time, common carps and tilapia were cultured. Since then, several donors assisted the government in aquaculture development. In 2002, there are 30 private- and state-owned hatcheries that are boosting seed production in the country.

Later support for aquaculture development in the country included three phases of a United Nations Development Program/Food Aquaculture Organization’s (UNDP/FAO) project that ran from 1980 to 2000. All three phases aimed to develop technical expertise at the household level.

The UNDP/FAO and other projects have tended to focus on the poorer northern provinces and not on the relatively fish abundant southern provinces of the country. However, there has been increasing attention on the southern provinces over the last decade through the Asian Institute of Technology’s Aqua Outreach Program and the Provincial Aquaculture Development project (the third and the final phase of UNDP/FAO involvement).

Lao PDR considered the potential of aquaculture development through multidisciplinary systems approach wherein technical, economic, social and environmental issues are being recognized.

Shrimp uses in war
Shrimp shells and vinegar are now staples for the US Army troops - not as rations but in new bandages that stops heavy bleeding in minutes.

Dr. Kenton Gregory (cardiologist) and retired Col. Bill Weismann (former director of the US Army’s Combat Casualty Care Unit), scientists from Portland, Oregon searched for a solution to the age-old problem of how to keep soldiers from bleeding to death on the battlefield. They stumbled on the kitchen pantry combination and, through high-tech wizardry, turned it into a super-sticky, combat-ready field dressing. They have taken orders for 10,000 of the bandages, which won the expeditious approval of the Food and Drug Administration.

About three years ago, the Army asked Gregory and Weismann to do what military surgeons have puzzled over since the Trojan War -- develop the perfect field dressing. It had to be easy to use, light, and stable with a long shelf life and had to be able to withstand a lot of temperature variation. And obviously it had to be safe and cheap. The Army gave them a $400,000 grant to develop a prototype. "It was unreasonable but we gave it a shot," Gregory said.

It took about a year of testing different substances - some unorthodox - for them to settle on chitosan, a naturally occurring protein found in shrimp shells. One of the guys in their team, Rui-Qing Qian, remembered something from the 1950s that the component that makes up shrimp shells when it comes in contact with red blood cells causes them to clot.

During initial tests, the substance quickly stopped aortic bleeding in pigs but test bandages kept falling apart. Australian Scientist Simon McCarthy added vinegar and a chain of about 20 chemical reactions to stabilize the bandage and make it stick tight to wounds so soldiers could be transported from field to hospital without disturbing the clot.

The first tests were made last November at the Army Institute of Surgical Research at Fort Sam Houston, Texas. The experimental bandage was first tried on swine whose livers were lacerated and the tests were a success. The Army scientists who tested the bandage praised its simplicity and minimal storage requirements after it saved all but one of eight gravely wounded animals. - AP Wire Services

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It took about a year of testing different substances - some unorthodox - for them to settle on chitosan, a naturally occurring protein found in shrimp shells. One of the guys in their team, Rui-Qing Qian, remembered something from the 1950s that the component that makes up shrimp shells when it comes in contact with red blood cells causes them to clot.

During initial tests, the substance quickly stopped aortic bleeding in pigs but test bandages kept falling apart. Australian Scientist Simon McCarthy added vinegar and a chain of about 20 chemical reactions to stabilize the bandage and make it stick tight to wounds so soldiers could be transported from field to hospital without disturbing the clot.

The first tests were made last November at the Army Institute of Surgical Research at Fort Sam Houston, Texas. The experimental bandage was first tried on swine whose livers were lacerated and the tests were a success. The Army scientists who tested the bandage praised its simplicity and minimal storage requirements after it saved all but one of eight gravely wounded animals. - AP Wire Services

The country held its first private-sector led effort to bring together the manufacturers of goods and services in aquaculture, the research-academe and the government sectors in an aquafarming congress from 7 to 10 May in Bacolod City, and organized by Cruz Aquaculture Corp. According to the Department of Agriculture, aquaculture accounted for 1.34 million tons or about 40% of total fish production; the remaining is shared by commercial and municipal capture fisheries. ###
in this region (9). In two coastal ecosystems (Ensenada del Pabellon and Bahia de Santa Maria) in the Gulf of California, Mexico, considered to be the biggest shrimp producers in the region, residues of endosulfan and other pesticides were detected in shrimps presumably coming from surrounding farms. Pesticide use has largely been blamed for the slow growth, diverse pathologies, and low survival of shrimps in this region in recent years (10). Thus, the impact of endosulfan contamination of aquatic ecosystems on wildlife is presumably confined to regions with high pesticide use and does not appear to be widespread in the coastal environment. But with endosulfan having one of the highest hazard ratings among pesticides, ill effects on the living organisms in affected areas can be significant.

**Chronic and sub-lethal effects**

The chronic and sub-lethal effects of endosulfan contamination of aquatic biota is only beginning to be known due to recent advances in the laboratory tools used in the biomonitoring of aquatic pollutants. While lethal effects are observed immediately as toxicity, chronic effects on organs and tissues of organisms are not readily apparent except when investigated in detail after toxicity or mortality in the population has already occurred. Since the digestive tract is the first organ of aquatic organisms that comes in contact with food- or water-borne pollutants and the liver is the site for storage, biotransformation, and excretion of endosulfan, characterization of the cellular and subcellular degenerative effects is a sensitive tool for monitoring the sub-lethal effects of the pesticide. Other physiologic functions such as osmoregulation, reproduction, and molting in the case of crustaceans may also be adversely affected by sub-lethal concentrations present in the water, suspended solids, or sediment.

Degenerative changes occurring through time have been observed in the cellular and subcellular structures of the intestine and/or liver of fishes such as rainbow trout *Oncorhynchus mykiss*, carp *Cyprinus carpio*, and mosquito fish *Gambusia affinis* exposed to endosulfan (11, 12, 13). Some of these toxic cellular effects have been observed at endosulfan concentrations as low as 0.01 microgram/liter similar to those measured in natural water bodies. Endosulfan also promotes peroxidative damage on the lipids of the liver, kidney and the gills of the freshwater fish *Channa punctatus* Bloch exposed to 5 micrograms/liter endosulfan (14). In the catfish *Clarias batrachus*, sub-lethal concentrations of endosulfan reduce the specific activity of liver malate dehydrogenase, a key enzyme in energy metabolism (15). Endosulfan is also toxic to isolated adrenocortical cells of rainbow trout *Oncorhynchus mykiss* and possesses the potential to disrupt the normal process of adrenal steroid production in the species (16, 17). Endosulfan is also capable of altering the gonad structure in juvenile and adult zebrafish which presumably results from alterations in primordial germ cells of embryos (18).

In other vertebrates, endosulfan and other pesticides have been instrumental in the decline of several species of frogs (anuran amphibians). Reduced cholinesterase activity, a key enzyme in the central nervous system function, in tadpoles *Hyla regilla* has been observed in areas with poor populations of these amphibians as in the case of those found near vast agricultural areas in the Sierra Mountains east of Central Valley, California. Measurable endosulfan and organophosphorus pesticide residues were seen in majority of sample frog populations (19).

In invertebrates, exposure of the prawn *Macrobrachium malcolmsonii* to sub-lethal concentrations of endosulfan (11-32 nanograms/liter) alter the cells of the hepatopancreas and cause swelling and necrosis of the gill lamellae. These disruptions likely affect the absorption, storage, and secretion of nutrients in the hepatopancreas; respiration and osmoregulation in the gills; and growth and survival of the prawn (20). In the fiddler crab *Uca pugilator*, endosulfan significantly inhibits chitobiase activity in the hepatopancreas which could slow down the normal molting process (21). Thus, sub-lethal concentrations of endosulfan disrupt the absorption, storage, and metabolism of nutrients in fish and crustaceans. Reproductive performance in fish and other vertebrates and osmoregulation in crustaceans are also adversely affected by low levels of the pesticide.

Chronic exposure to low levels of endosulfan has been shown to affect higher animals and humans. Endosulfan treatment decreases testicular function in the rat (22). Residues of endosulfan are found in yolk or embryos of white leghorn hens treated with endosulfan, which suggests that exposure of the chick can occur as a consequence of maternal exposure to the pesticide (23). Furthermore, protein malnutrition in the rat makes it susceptible to intestinal tissue damage by endosulfan (24). Recent studies done in human cell lines have supported the finding that endosulfan is a xenoestrogen, an exogenous chemical that mimics the action of natural, endogenous estrogen, which can potentially disturb sex hormone action. Xenoestrogens are suspected of causing a host of human diseases including cancer. Endosulfan can act as both an estrogen agonist (mimics the function of the hormone) and an anti-estrogen antagonist (opposes the function of the hormone) and its effects can be amplified by the presence of other pesticides (25). It has also been shown to activate the estrogen receptor in normal and cancerous cells of the smooth muscles of the uterus (26) and is genotoxic to human HepG2 cells *in vitro* by causing chromosomal damage (27). Endosulfan can also affect human immune function by inducing cell death or apoptosis in T-cells and thymocytes (28). Lastly, endosulfan residues have been demonstrated in biological samples coming from people who have been exposed to the pesticide. Detectable and significant levels of endosulfan have been found in human milk (29), semen from normal males (30), cord blood samples taken after delivery (31) suggesting in utero exposure to pesticides, and fat samples from children living near farming areas (32).

**Incorrect use against snail pests in rice paddies**

Endosulfan has been indiscriminately used as a molluscicide to control the golden apple snail *Pomacea canaliculata* in rice paddies in the Thai provinces of Pathum Thani, Suphan Buri, Nakorn
Pathom, Nonthaburi, and Chachoengsao, where supposedly its use is disallowed. Although endosulfan is not recommended for use as a molluscicide, majority of the 234 rice farmers surveyed found it effective against the snail pests after 1-3 applications during the pre-planting or post-planting stages. Farmers had used endosulfan for 1-5 years or more prior to the survey after favorable recommendations from the supplier and their neighbors. Spraying or splashing of the water-based emulsion was the preferred method of application. Farmers seldom drained the water from the rice paddies, but when they did, they usually drained the water 1-3 days after the first application into the next field, irrigation canal, or river. As expected, mortality in fish, snakes, and frogs were observed in the rice paddies and in irrigation canals. Those who applied the pesticide complained of headache, skin irritations, and nausea (33).

Although endosulfan degrades rapidly in water, significant residues in the water, soil, rice, and straw remain after application. The biological effect of such residues depends on concentration. Right after application, the concentration of the pesticide is high, which is very toxic to target and non-target organisms in the paddy. In time, the pesticide is degraded, the concentration is diminished, and the apparent effects on aquatic organisms considerably reduced. However, effects on water and soil microorganisms and plankton are usually overlooked and the sub-lethal effects on aquatic animals are difficult to determine without more detailed and extensive investigations. With the more widespread adoption of the rice-fish farming system during the growing season for rice, concern about bioconcentration of endosulfan residues in the fish and its hazard to human health is warranted.

In experiments conducted to monitor endosulfan residues in the rice paddies after application, total endosulfan residues (sum of α-, β-endosulfan and endosulfan sulfate) as high as 342 micrograms/liter was observed right after application (day 1). At day 1 after the second application (at day 10), total residues in the water were as high as 44 micrograms/liter and at day 1 after the third application (at day 20), residues were as high as 56 micrograms/liter. At day 48 after the first application, total residues in the water was 3 micrograms/liter, which was still well within the LC₉₀ for fish of 1-10 microgram/liter, but way above sub-lethal concentrations known to affect some physiologic functions in aquatic animals. Residues of endosulfan in the soil at harvest were detectable at 130 micrograms/kg. Endosulfan residues were also detected in rice and straw (1 and 20 micrograms/kg, respectively), the CODEX MRL for rice and straw being 100 micrograms/kg (34). How much endosulfan residue is in the fish coming from such a rice-fish farming system perhaps needs to be determined to ensure safety to human health.

While endosulfan application may be limited to the rice paddy, pesticide residues may be transported after the release of the paddy water to other aquatic ecosystems such as irrigation canals, creeks, streams, rivers and fishponds that receive their water supply from these rivers, and lakes. Pesticide residues will affect the resident aquatic organisms in these areas as well as predatory animals such as birds and even humans. Volatility of the pesticide especially under hot and humid tropical conditions and subsequent transport by air and wind is difficult to assess (35).

Endosulfan residues in rivers near the paddy field areas in the Thai central plain were also monitored. Several water samples were obtained from Thachin river (from Suphan Buri to Nakorn Pathom), Chaophraya river (from Pathumthani to Nonthaburi), and Bangpakong river (from Chachengsao). Highest endosulfan residues were obtained in Thachin river (0.05-0.97 microgram/liter), followed by Chaophraya river (0.05-0.29 microgram/liter), and then by Bangpakong river (0.01-0.24 microgram/liter) (36). Although these concentrations did not exceed the LC₉₀ value of endosulfan for fish of 1-10 microgram/liter and no fish kills have so far been observed, sub-lethal effects on non-target organisms are likely to occur as a result of these measurable levels of endosulfan. Residues of endosulfan in fish, crustaceans, and other aquatic commodities for human consumption coming from these rivers should also be determined.

Summary and conclusion

A clean and healthy environment is paramount to human existence. While pesticide use has successfully sustained agricultural and food production in our lifetime as well as safeguarded human health by controlling insect pests, it has also caused many tragedies including population declines in our wildlife, fatalities in workers exposed to pesticides in its manufacture and use, and the increasing incidence of dreaded human illnesses such as cancer. A delicate balance should be achieved to mitigate the adverse impact of pesticide use to the environment and at the same time ensuring short- and long-term agricultural productivity.

Endosulfan has been effectively used as a pesticide, but much evidence on its chronic and sub-lethal effects on humans and wildlife have been gathered in recent years. More research still needs to be done to determine its effects from long-term exposure at very low levels. Endosulfan is highly toxic to fish and other aquatic animals and, thus, not recommended for use in aquatic ecosystems. However, in some countries, it has been incorrectly used as a molluscicide in rice paddies, which could have an adverse impact on the rice-fish farming systems and on other surrounding aquatic ecosystems. It is clear that such practices should be stopped and users must strictly observe the recommended application methods.

Agricultural productivity should be achieved with much less pesticide by using integrated pest management programs which make use of biological, cultural, and physical control agents and lower doses of safer pesticides on a need only basis. The benefits of biotechnology should also be used to develop more effective and safer products and techniques. This is a valid approach and one that will require a unified and concerted effort among suppliers and users of pesticides in order to ensure that resources are used to our best advantage with minimal risk.

Acknowledgment

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33 Purivirojkul W, Arayanurongsart L. 2001. Survey on the use of endosulfan for golden apple snail control in farmer fields of Central Plain. Proceedings from the Rice Research Institute, Department of Agriculture, Meeting No. 5, November 21-23, Bangkok, Thailand, p 119-128

The bigger rooms contain bigger containers of the microscopic plants (maintenance cultures) that are maintained to be ready for transfer to tanks anytime for researchers at AQD or for sale to buyers for hatchery use.

A few steps from this laboratory is the zooplankton laboratory. Here, copepods, *Artemia* sp., and *Brachionus* sp. undergo more or less the same process as the microscopic plants. Where the plant laboratory showed only containers of aerated brown and green water, this laboratory is more interesting as the macroscopic animals are visible through the glass beakers if one knew what to look for. Copepods are very tiny translucent, almost circular wriggling organisms with feet much resembling lice.

The following list shows the plankton species cultured at AQD and the corresponding fish that thrive on them in the hatchery or ponds. The density or biomass needed for various stages of the culture animals are prescribed in separate feeding management protocols.

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Industry growth and live food

Growth of aquaculture depends upon the availability of a ready supply of larvae that can be grown to marketable size. A ready supply of larvae in turn needs quality and sufficient live food to promote rapid growth, provide protection from some diseases, carry natural enzymes that help digest artificial food when fed in combination, and maintains water quality. Fifty percent of feed depends on live food; artificial feed cannot fully replace live food requirements.

But live food production can be very expensive. A 1993 study on the economics of one microalgae production done at AQD reported that equipment was 84% of the total asset cost. The acquisition of equipment specifically for microalgae culture is a major cost incurred in the initial investment. In actual production, the consumables are add-on expenses.

Today, aquaculture producers know that buying starter cultures from big laboratories is convenient. If a buyer still does not know how to grow the microalgae, they get a bonus of a free lecture from AQD. This makes the live food laboratory an indispensable set-up for the industry.
Present prices of algal starters/media are:

**Algae (any species)**
- P100/liter aerated
- P 100/test tube unaerated in liquid or solid media

**Rotifer (Brachionus)**
- P100/million

**Media/nutrients**
- P1,170/set for F-medium - for Isochrysis, Skeletonema, and Chaetoceros
- P700/liter for Conway medium - for Nannochlorum, Tetraselmis, Nannochloropsis oculata
- P200/set for TMRL medium - for bigger cultures of any species

**Future activities**

No doubt in the future, live food would become a new market niche along with the other profit-making production components of aquaculture. AQD has never been ready for this than now. The present microalgal collection, considered basic for any growing live food laboratory, has constantly been growing. Indeed, indigenous live food has always been used by traditional aquaculture practitioners but have never been systematically studied.

Taxonomic studies have to confirm the species studied, culture techniques have to be established for newly isolated species and strains, ecological studies such as population dynamics and determination of environmental factors as well as the nutritive value have to be investigated. These are just a few of the many things that need to be done. A bioreactor or fermentor has to be acquired and harvest and storage techniques established. Screening and extraction of bioactive compounds with nutritive and pharmaceutical values are possibilities for the live food industry. - MBS

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**Endosulfan: a hidden menace by r m coloso**

**ENDOSULFAN ... from page 18**

Disease Control in Fish and Shrimp Aquaculture in SEA - Diagnosis and Husbandry Techniques, 215 pages, edited by Yasuo Inui and Erlinda Cruz-Lacierda. This volume contains the 14 papers presented at a seminar-workshop held December 4-6, 2001 that was organized by SEAFDEC and the Office International des Epizooties. For a copy, contact Dr Erlinda Cruz-Lacierda at eclacier@aqd.seafdec.org.ph or fax (63-33) 5118709, 3351008.

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**Contributions**
We accept articles that focus on issues, developments, and information on all phases of sustainable aquaculture for publication in this newsletter. Photographs and line drawings must be camera-ready, glossy B&W prints or colored slides. The newsletter editor reserves the right to edit contributed articles for brevity and style.

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Live food: a lesser known essential
SEAFDEC/AQD’s live food laboratory is vital to industry growth

There are lesser known areas in the aquaculture production process that, upon closer inspection, prove to be complex operations in themselves. One such area is live food production, an important requirement of a successful hatchery operation as the availability of suitable food can make or break the hatchery run.

Live food, commonly called natural food, are food organisms in the natural habitat of fish. These food organisms include small plants and animals (phytoplankton, zooplankton), and some big ones (aquatic macrophytes). Of the many food species of microalgae that thrive in seawater, only a few can be cultivated successfully in the hatchery because conditions can be environmentally demanding. In ponds, the actual live food for fish are lablab which is a complex of blue-green and green algae, diatoms, rotifers, crustaceans, insects, roundworms, detritus, plankton; and lumut, which are fibrous, filamentous green algae.

This article is a short discussion of the requirements for live food production in aquaculture and a brief presentation of the processes involved.

Live food production at SEAFDEC/AQD
AQD has a live food laboratory that develops techniques for mass production of plankton as food for larvae of fish, crustaceans, and mollusks raised in hatcheries. It maintains a microalgal collection and now has more than 50 local and foreign strains and species. More than 30 others are being studied by researchers and would eventually become a part of the collection.

A visit to the laboratory would take one to heavily airconditioned backrooms with a very small isolation room. Here, a single cell microscopic plant (phytoplankton) is separated and identified from a sampled pond or seawater. The single cell would be grown into colonies in test tubes in either liquid or agar medium (pure culture). A growing colony in a test tube would show microalgal patches clinging to the sides of the test tube. It is then transferred to erlenmeyer flasks where it is allowed to grow further (stock culture).